Local study of the domain wall mobility in ferroelectric ceramics under the action of electric field and mechanical loading

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Domain wall motion in heterogeneous multiaxial materials is quite complicated due to variety of factors necessary to be taken in consideration. Different interfaces such as grain and phase boundaries, domain walls as well as defect structure can impact to the domain growth [1]. It is rather complicated to distinguish the contributions of each mechanism by analysis of the macroscopic studies. Whereas piezoresponse force microscopy allows to realize visualization of the domain structure and determination of the spontaneous polarization orientation.

Here we studied bismuth ferrite (BFO) ceramics, doped by La and Pr, with a composition near the antipolar-to-polar morphotropic phase boundary sintered by conventional solid-phase path. Both electric-field induced polarization reversal by scanning probe microscopy tip and local switching under the mechanical loading action were investigated. Dependences of in-plane and out-of-plane polarization switching on grain orientation were found for non-180-degree domain walls. The mobility of the non-180-degree domain walls was significantly lower than 180-degree walls. Domain wall motion velocity of all domain walls depends linearly on the applied field and the wall displacement demonstrates close-to-logarithmic dependence on voltage pulse duration, which is in line with other homogeneous and heterogeneous systems [2, 3]. The grain boundaries and initial domain structure didn't interact with growing domains through the distortion of electric field, however the switching spectroscopy allowed to reveal existence of frozen polarization component. Polarization reversal via mechanical loading (nano-indentation) resulted in formation of domains in indented area with spatial distribution determined by asymmetry of the stress created with the triangular shaped prism. Electric field and mechanical loading induced local switching was studied in relation to phase content of BFO ceramics and thereby these studies shed further light on understanding of antipolar-to-polar morphotropic phase boundary phenomena.

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